The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte GORLEY L. LAU

Appeal No. 2005-0325
Application No. 09/476,669

MAILED

MAR 24 2005

PAT. & T.M. OFFICE
BOARD OF PATENT APPEALS
AND INTERFERENCES

ON BRIEF

Before GARRIS, WARREN, and KRATZ, Administrative Patent Judges.

GARRIS, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on an appeal which involves claims 1-11 and 30.

The subject matter on appeal relates to methods for fabricating a metallization structure. The method according to appealed independent claim 1 comprises ion metal plasma depositing a wetting layer within a cavity of a dielectric layer

and applying a sufficient bias power to splash deposited metal at the bottom of the cavity to sidewalls of the cavity. The method according to independent claim 30 comprises etching a cavity within a dielectric layer, ion metal plasma depositing a wetting layer consisting essentially of titanium on and in contact with the base and sidewalls of the cavity, and sputter depositing substantially an entirety of a bulk metal layer on and in contact with the wetting layer. This appealed subject matter is adequately illustrated by the aforementioned independent claims 1 and 30 which read as follows:

1. A method for fabricating a metallization structure, comprising:

ion metal plasma depositing a wetting layer within a cavity of a dielectric layer;

applying a sufficient bias power to splash deposited metal at the bottom of the cavity to sidewalls of the cavity, wherein said applying occurs during said ion metal plasma depositing the wetting layer; and

sputter depositing, within a single chamber, substantially an entirety of a bulk metal layer upon the wetting layer.

30. A method for fabricating a metallization structure, comprising:

etching a cavity comprising a base and opposing sidewalls within a dielectric of a topography;

ion metal plasma depositing a wetting layer consisting essentially of titanium on and in contact with the base and the sidewalls of said cavity; and

sputter depositing substantially an entirety of a bulk metal layer on and in contact with the wetting layer.

The references relied upon by the examiner in the section 102 and section 103 rejections before us are:

Ong	5,371,042	Dec. 6, 1994
Kim et al. (Kim)	5,985,759	Nov. 16, 1999
Satitpunwaycha et al. (Satitpunwaycha)	6,045,666	Apr. 4, 2000 (filed Nov. 24, 1997)
Xu et al. (Xu)	6,217,721	Apr. 17, 2001 (filed Apr. 5, 1996)

Claims 1, 3-7, 11 and 30 are rejected under 35 U.S.C. § 102(e) as being anticipated by Kim.

Under 35 U.S.C. § 103(a): claim 2 is rejected over Kim in view of Satitpunwaycha; claim 8 is rejected over Kim in view of Xu; and claims 9 and 10 are rejected over Kim in view of Ong.

We refer to the brief and reply brief and to the answer for a complete exposition of the opposing viewpoints expressed by the appellant and by the examiner concerning the above noted rejections.

OPINION

For the reasons which follow, these rejections cannot be sustained.

Concerning the section 102 rejection of claim 1, the appellant correctly argues (and the examiner does not disagree)

that the Kim reference contains no express disclosure of the here claimed step "applying a sufficient bias power to splash deposited metal at the bottom of the cavity to sidewalls of the cavity." In essence, it is the examiner's position that Kim's method for fabricating a metallization structure would inherently practice this step. In support of this inherency position, the examiner proffers the following rationale in the paragraph bridging pages 9 and 10 of the answer:

> Kim deposits the titanium wetting layer using IMP and conditions which are nearly identical to the ranges set forth in the instant application (see page 21, ll. 20-29 of the instant application and Table 1 of Kim) and additionally teaches of [sic] applying a wafer bias from 0-500 W during deposition. Given the fact that the process conditions are nearly identical for depositing the same material, a titanium wetting layer, and the range of 0-500 W includes the range of 100-200 W, there is a clear rationale for expecting that at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls.

A finding of anticipation by inherent disclosure is appropriate only when the reference discloses prior art that must necessarily include the unstated limitation. Transclean Corp. v. Bridgewood Services, Inc., 290 F.3d 1364, 1373, 62 USPQ2d 1865, 1871 (Fed. Cir. 2002). That is, inherency may not be established by probabilities or possibilities, and the mere fact that a certain thing may result from a given set of circumstances is not

sufficient. MEHL/Biophile Int'l Corp. v. Milgraum, 192 F.3d 1362, 1365, 52 USPQ2d 1303, 1305 (Fed. Cir. 1999). It follows that, in order for a claim to be inherent in the prior art, it is not sufficient that a person following the reference disclosure sometimes obtains the result set forth in the claim; it must invariably happen. Glaxo, Inc. v. Novopharm, 830 F. Supp. 871, 874, 29 USPQ2d 1126, 1128 (1993).

These legal principles clearly reveal the examiner's inherency position to be improper. Manifestly, an inherency determination is not supported by the mere fact that Kim discloses a biasing power range of 0-500 W which encompasses the appellant's disclosed range of 100-200 W. This is because patentee's bias power range includes values, such as 0 which is Kim's most preferred (i.e., optimum) process condition (e.g., see Table 1 in column 13), that unquestionably would be insufficient to splash deposited metal at the bottom of the cavity to sidewalls of the cavity as required by appealed claim 1.[1] Thus,

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[1] The anticipation finding reached in the minority opinion seems to be based on (1) the proposition that Kim discloses an alternative method wherein the fourth (wetting) layer is created via the less preferred IMP (rather than the most preferred traditional) sputter deposition and wherein this IMP deposition is performed under conditions which are optimum for creating the first (barrier) layer and (2) the proposition that these last mentioned conditions would inherently "splash deposited metal at
(continued...)

while a person following Kim's disclosure might sometimes obtain the here claimed result, this does not establish inherency. In order to establish inherency, the result must invariably happen. Glaxo, Inc. v. Novopharm, 830 F. Supp. at 874, 29 USPQ2d at 1128.

In light of the foregoing, the examiner's section 102 rejection of claim 1 as being anticipated by Kim cannot be sustained.

In support of his section 102 rejection of independent claim 30 and specifically concerning the claim limitation "a wetting layer consisting essentially of titanium," the examiner emphasizes that "the transitional phrase 'consisting essentially of' limits the scope of a claim to the specified materials or steps 'and those that do not materially affect the basic and novel characteristic(s)' of the claimed invention. In re Herz,

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[1](...continued)
the bottom of the cavity to sidewalls of the cavity" as required by appealed claim 1. This anticipation finding is improper because these propositions are tainted with impermissible conjecture (see W.L. Gore & Assocs. v. Garlock, Inc., 721 F.2d 1540, 1554, 220 USPQ 303, 314 (Fed. Cir. 1983)) based on a reference disclosure which is at best ambiguous (see In re Turlay, 304 F.2d 893, 899, 134 USPQ 355, 360 (CCPA 1962)). Moreover, contrary to the minority's apparent belief, a condition which is optimal does not establish inherency. See In re Rijckaert, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993). Finally, the anticipation rationale of the minority differs substantially from that of the examiner and therefore cannot be relied upon for sustaining the section 102 rejection advanced on this appeal.

537 F.2d 549, 551-52, 190 USPQ 461, 463 (CCPA 1976)" (answer, page 17). With further regard to this claim limitation, the examiner points out that "Kim clearly teaches of [sic] a wetting layer which is titanium (col. 8, ll. 34-42) and further that it is not desired to have reactive species (nitrogen and/or oxygen) contaminate the wetting layer (col. 2, ll. 6-24)" and urges that "[t]herefore, contrary to Appellant's arguments, Kim is held to teach of [sic] a wetting layer consisting essentially of titanium" (answer, page 19).

We agree that Kim discloses a "wetting layer 26 of titanium" (column 8, lines 36-37), and the appellant does not contend otherwise. Instead, it is the appellant's contention that the Kim patent fails to satisfy the claim 30 requirement for a wetting layer consisting essentially of titanium which is "on and in contact with the base and the sidewalls of said cavity." We agree. As correctly indicated by the appellant and as clearly disclosed in Figure 7 of patentee's drawing and the specification disclosure relating thereto, titanium wetting layer 26 is separated from the base 18 and sidewalls 15 of cavity or via 10 by a plurality of other layers including titanium nitride layer 24 and oxygen stuffed titanium and/or titanium nitride layer 20.

The examiner may believe that these other layers of Kim fall within the scope of the claim 30 wetting layer by virtue of the claim phrase "consisting essentially of," although no such belief is expressly stated by the examiner. Assuming this belief is implicitly held by the examiner, we consider it to be not well taken. Pursuant to patentee's teachings, these other layers do not perform a wetting function but instead perform other functions. For example, titanium nitride layer 24 functions as "the main barrier layer to prevent the migration of silicon to the top of the barrier structure, where it could react with aluminum during filling of the contact" (column 8, lines 31-33). Under these circumstances, no basis exists for considering these other layers of Kim as encompassed by the claim 30 recitation "a wetting layer consisting essentially of titanium."

For these reasons, we also cannot sustain the examiner's section 102 rejection of appealed independent claim 30 as being anticipated by Kim.

The other references applied in the section 103 rejections before us have been relied upon by the examiner for purposes unrelated to the above discussed deficiencies of Kim. It follows that these deficiencies are fatal to both the section 102 and section 103 rejections advanced on this appeal. Therefore, we

hereby reverse: the section 102 rejection of claims 1, 3-7, 11 and 30 as being anticipated by Kim; the section 103 rejection of claim 2 as being unpatentable over Kim in view of Satitpunwaycha; the section 103 rejection of claim 8 as being unpatentable over Kim in view of Xu; and the section 103 rejection of claims 9 and 10 as being unpatentable over Kim in view of Ong.

The decision of the examiner is reversed.

REVERSED

Bradley R. Garris Administrative Patent Judge	)))BOARD OF PATENT) APPEALS AND) INTERFERENCES)
Peter F. Kratz Administrative Patent Judge	)))

BRG:tdl

WARREN, *Administrative Patent Judge*, Concurring-in-part and Dissenting-in-part:

I agree with the decision of the majority of this panel to reverse the ground of rejection of appealed independent claim 30 under 35 U.S.C. § 102(e) over Kim et al. (Kim) and thus, the decision of the examiner with respect to this claim.

I disagree with the decision of the majority of this panel to reverse the grounds of rejection of appealed claims 1, 3 through 7 and 11 under § 102(e) over Kim, and of claim 2, claim 8 and claims 9 and 10 under 35 U.S.C. § 103(a) over Kim taken in view of Satitpunwaycha et al., of Xu et al. and of Ong, respectively, and thus, I would affirm the decision of the examiner with respect to these claims.

The review of the grounds of rejection of independent claim 1 and claims 2 through 11 directly or ultimately dependent thereon, first requires that the language of claim 1 (*see above* pp. 2-3) must be interpret by giving the terms thereof their broadest reasonable interpretation in light of the written description in appellant's specification, including the drawings, as it would be interpreted by one of ordinary skill in this art, in the light of arguments advanced by the examiner and appellant, without reading into this claim any limitation or particular embodiment disclosed in the specification. *See In re Morris*, 127 F.3d 1048, 1054-55, 44 USPQ2d 1023, 1027 (Fed. Cir. 1997); *In re Zletz*, 893 F.2d 319, 321-22, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989); *In re Priest*, 582 F.2d 33, 37, 199 USPQ 11, 15 (CCPA 1978).

The plain language of the first and second clauses of claim 1 makes clear that "[a] method for fabricating a metallization structure" comprises at least the step of "applying a sufficient bias power" to "a cavity of a dielectric layer" during the "ion metal plasma" deposition of "a wetting layer" therein "to *splash* deposited metal at the bottom of the cavity to sidewalls of the cavity" (emphasis supplied). The key term "splash" appears on this record to be a non-scientific term adopted by appellant to characterize the events which occur when metal atoms in a layer being deposited in the bottom of a "cavity," e.g., a "contact," during an "ion metal plasma" (IMP) deposition process are impacted during that process with sputtered metal ions having sufficient

energy through pedestal bias to cause said metal to "resputter" onto the sidewalls of the "cavity," in view of the following disclosure in the written description in the specification:

> [T]he present method is *preferably configured to deposit metal atoms with sufficient force to sputter previously deposited metal away from the ion impact area.* The *impact energy* of the metal ions on the microelectronic topography is largely determined by the *pedestal bias.* A greater pedestal bias will increase the energy with which the ionized metals impact the deposition surface. The present process preferably incorporates *a pedestal bias configured to deposit metal atoms with sufficient force to sputter previously deposited metal* and reduce or prevent the problems discussed above. This feature allows *for sputtering away of excess material on the tapered sidewall portions,* and thus helps to prevent shadowing of other cavity sidewall portions. *In addition, the sputtered metal ions may impact with previously deposited metal at the bottom of the trench with sufficient energy to resputter, or "splash," that metal onto lower cavity sidewalls 208.* [Paragraph abridging pages 20-21 of the specification as amended in the amendment filed December 9, 2002; emphasis supplied.]

Indeed, this is the only occurrence of the term "splash" in the written description in the specification, and I fail to find a definition for the term "splash" in the context of a sputtering method in scientific and non-scientific dictionaries. *See, e.g., McGraw-Hill Dictionary of Scientific and Technical Terms* 1698, 1890 (Sybil P. Parker, ed., New York, McGraw-Hill, Inc. 1994); *Webster's Third New International Dictionary* 1935, 2200 (Phillip Babcock Gove, ed., Springfield, Massachusetts, Merriam-Webster Inc. 1993).

Thus, I am of the view that, on this record, the term "splash" is synonymous with the term "resputter."

Furthermore, an IMP deposition process with "sufficient bias power" as generically specified in the language of claim 1 encompasses *any* process falling within this art recognized type of sputtering process wherein, for example, the "cavity" or "contact" is in a "substrate toward which the sputtered ions are moving [that] is typically biased to attract incoming ions" by a substrate support or pedestal electrode, as acknowledged by Kim to be known in the prior art at that time for use in preparing "small contacts" (col. 1, ll. 40-55), and as also acknowledged by

appellant (specification, e.g., page 2, ll. 19-24). Indeed, there is no disclosure in the written description in the specification that appellant invented IMP sputtering *per se* (specification, e.g., page 5, ll. 13-25).

The "wetting layer" in claim 1 encompasses any suitable metal, and can comprise titanium as specified in claim 11, and there is no specified dimension or configuration for the "cavity," or for the depth of the "wetting layer" on the bottom or the sidewalls of the cavity either at the point in the IMP process where at least one metal atom in said layer at the bottom of the cavity is "resputtered" or "splashed" to the sidewalls of the cavity, or at the end of the IMP process. Claim 1 further specifies "sputter depositing . . . a bulk metal layer upon the wetting layer."

The examiner takes the position that "the claims are not limited to a particular wafer bias range or amount of splashing . . . [and] [t]hus the claims are open to any wafer bias levels which will cause at least a minute degree of splashing or more" (answer, pages 9, 11, 13 and 15). Appellant states that "a specific range of bias power is not claimed in the present case[,] [r]ather, a level which is capable of producing a particular action is claimed" (brief, page 7), and "agrees with the Examiner's assertion that the claims are not limited to a particular wafer bias range or an amount of splashing" (reply brief, page 2).

I also agree and determine on this record that claim 1 encompasses methods in which the step of IMP sputter depositing a wetting layer in a cavity includes "resputtering" or "splashing" one metal atom or more than one metal atom so deposited in that layer at the bottom of the cavity by a metal ion "to sidewalls" of that cavity by any "sufficient" substrate electrode or pedestal "bias power" that achieves such result.

Turning now to the application of Kim to claim 1 under § 102(e), it is well settled that in order for the examiner to establish a *prima facie* case of anticipation, each and every element of the claimed invention, arranged as required by the claim, must be found in a single prior art reference, either expressly or under the principles of inherency, in a manner sufficient to have

placed a person of ordinary skill in the art in possession thereof. *See generally*, *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999); *In re Schreiber*, 128 F.3d 1473, 1477, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997); *In re Paulsen*, 30 F.3d 1475, 1478, 31 USPQ2d 1671, 1673 (Fed. Cir. 1994); *In re Spada*, 911 F.2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990); *Diversitech Corp. v. Century Steps, Inc.*, 850 F.2d 675, 677-78, 7 USPQ2d 1315, 1317 (Fed. Cir. 1988); *Lindemann Maschinenfabrik GMBH v. American Hoist and Derrick Co.*, 730 F.2d 1452, 1458, 221 USPQ 481, 485 (Fed. Cir. 1984). Whether the teachings and inferences that one skilled in this art would have found in the disclosure of an applied reference would have placed this person in possession of the claimed invention, taking into account this person's own knowledge of the particular art, is a question of fact. *See generally, In re Graves*, 69 F.3d 1147, 1152, 36 USPQ2d 1697, 1701 (Fed. Cir. 1995), and cases cited therein (a reference anticipates the claimed method if the step that is not disclosed therein "is within the knowledge of a skilled artisan."); *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968) ("[I]n considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but also the inferences which one skilled in the art would reasonably be expected to draw therefrom.").

I find that Kim discloses to one skilled in this art methods of preparing a multi-layer barrier system for very small contact vias which encompass the formation of a fourth layer described as "a wetting layer," that can be formed of titanium, "by IMP sputter deposition" prior to the sputter deposition of a bulk metal layer upon that wetting layer, even though the IMP sputter deposition is disclosed as an alternate process to the preferred "traditional (i.e., diode) sputter deposition" of that layer (e.g., col. 2, ll. 38-40, 47-50 and 65-67; col. 3, ll. 1-3, 21-25 and 51-53; col. 3, l. 67, to col. 4, l. 2; col. 4, l. 51-53; col. 5, ll. 10-18; col. 6, ll. 1-5; col. 7, ll. 13-15; col. 8, ll. 35-42, and **FIG. 6**; col. 9, ll. 1-15; and col. 11, ll. 4-6).

I find that one skilled in this art would have further found in Kim the following definition for "IMP sputter deposition:"

> [t]he term "Ion Metal Plasma" ("IMP") or "ion sputtering deposition" refers to sputter deposition . . . where a high density, inductively coupled RF plasma is positioned between the sputtering cathode and the substrate support electrode, whereby at least a potion of the sputtered emission is in the form of ions at the time it reaches the substrate surface. [Col. 6, ll. 15-22.]

Kim further employs the following definition for "traditional sputter deposition:"

> [t]he term "traditional sputtering" refers to a method of forming a film layer on a substrate wherein a target is sputtered and the material sputtered from the target passes between the target and the substrate to from a film layer on the substrate, and no secondary means is provided to ionize a substantial portion of the target material sputtered from the target before it reaches the substrate. The power to maintain the plasma and thus provide the ions to sputter the target is provided, for example through the target, which is negatively biased . . . . [Col. 6, ll. 30-46; see also, e.g., col. 3, ll. 6-14.]

Kim also describes "traditional sputter deposition" as "diode sputtering" in similar terms: "the power to the target provides the power to support the plasma used to sputter the target, and no specialized energy source, such as an internal inductively coupled coil (for purposes of additional ion generation) or external microwave energy source, need be provided to support the standard source of plasma generation" (e.g., col. 3, ll. 6-14 and 20-22).

Kim still further discloses that the methods taught therein may be conducted in an Endura® Integrated Processing System from Applied Materials, Inc. (col. 6, ll. 49-54, and col. 13, ll. 33-38).

Kim describes forming a single layer consisting of titanium by IMP sputter deposition as follows:

> A first layer of titanium is deposited on the substrate surface by IMP sputter deposition with high density plasma, preferably with high wafer bias, so that the first titanium layer is mostly deposited at the bottom of the contact via, rather than on the sidewalls. *It is especially important to use high wafer bias (i.e., at least about –30 V) with small feature size (i.e., less than 0.5 μm) contact vias. By maintaining a high wafer bias, the trajectories of the ionized target atoms can be modified to be substantially perpendicular to the wafer, and thus in line with the depth direction of the contact/via*

> *structure, which enables many of the ionized atoms to reach the bottom of the contact/via structure. . . .*
>
> In this particular instance, chamber pressure and wafer bias are used to control contact/via sidewall coverage. *High wafer bias is used to reduce the amount of Ti deposited on the sidewall* and a limited increase in process chamber pressure may be used to increase the bottom coverage in a feature such as a contact/via. . . . [Col. 9, ll. 16-38.]

Kim discloses that annealing the first titanium layer is optional (col. 9, ll. 47-48).

Kim further provides Table 1 which "shows preferred, more preferred, and optimum process conditions for sputter depositions of the various layers of the barrier layer structure according to the method of the invention" (col. 12, ll. 19-23), produced in an Endura® Integrated Processing System (col. 13, ll. 33-38). The first process, "IMP Ti," appears to correspond to the first layer (col. 11-12), and the fourth process, "Ti," appears to correspond to the fourth "wetting" layer (cols. 13-14). In the "IMP Ti" process, the "RF Coil Power (W)" is "500-3500" in the first set of conditions and is at "2500" in the second and third sets of conditions (see, e.g., col. 3, ll. 4-6). The substrate or pedestal wafer bias conditions, designated "AC Wafer Bias (W)" and "AC Wafer Bias (-V)," range from "0-500 and "0-250, respectively, in the first set, and "0-450" and "0-120, respectively, in the second set. In the third or "optimum" set of conditions, the wafer bias power in these two values is "450" and "40-70," respectively, the latter "AC Wafer Bias (-V)" range being above the lower limit of "-30 V" for bias power taught for "small feature size . . . contact vias" (col. 9, ll. 21-23).

The process conditions also include conditions for the sputter deposition of bulk aluminum (cols. 13-14).

In the "Ti" process, the first set of conditions encompasses both "traditional sputter deposition," because the "RF Coil Power (W)" can be "0," as well as IMP sputter deposition conditions because the range extends to "3500," with the range in the second and third conditions being IMP sputter deposition conditions because the value is "1500." The substrate or pedestal

wafer bias conditions "AC Wafer Bias (W)" and "AC Wafer Bias (-V)" range from "0-500 and "0-250, respectively, in the first set of conditions, but in the second and third sets of conditions, the "AC Wafer Bias (W)" is "0" and "AC Wafer Bias (-V)" is only "2-3," which latter range is below the lower limit of "-30 V" for bias power taught for "small feature size . . . contact vias" (col. 9, ll. 21-23).

The examiner submits that Kim anticipates claim 1 because "[a] portion of the range for the ["AC Wafer Bias (W)" of 0-500 W in Table 1 in cols. 13-14,] is identical to the wafer bias ranges applied in the instant application (see page 21, lines 25-29 for example)," the identical portion in the reference being "sufficient to splash deposited metal at the bottom of the cavity to sidewalls of the cavity during IMP deposition of the wetting layer" with respect to claim 1 (answer, page 3).

Appellant submits that Kim does not anticipate claim 1 because "Kim discloses applying a bias power to the wafer during the deposition of a metal layer, as shown in Table 1 in column 13," but does not teach or suggest "that such an application of a bias power is sufficient to splash deposited metal at the bottom of a cavity to sidewalls of the cavity," arguing that "[o]n the contrary, Kim specifically teaches applying a wafer bias such that a layer may be '. . . mostly deposited at the bottom of the contact via, rather than on the sidewalls,'" citing col. 9, ll. 18-20, and makes no mention "of splashing deposited metal from the bottom of a cavity to the sidewalls of the cavity, particularly during an application of a bias power at a level sufficient to achieve such" result (brief, page 6).

Appellant further submits that while "[e]xemplary levels of a bias power" is disclosed at specification page 21, ll. 25-27, there is no claimed range, and "[t]he fact that Kim teaches a range of bias power that overlaps with the exemplary levels cited in the [s]pecification . . . does not overcome . . . a lack of disclosure" in Kim "of applying bias power at a level sufficient to splash deposited metal at the bottom of a cavity to the sidewalls of the cavity" (brief, page 7). Appellant alleges that "the range of bias power needed to splash metal . . . may depend on a

variety or parameters of the deposition process, such as but not limited to, the temperature and/or pressure of the deposition chamber, for example" and that "size of the topography upon which a layer is deposited may affect the level of the bias power to sufficiently perform such a function" (*id.*). In these respects, appellant contends that Kim discloses "that sidewall coverage may be controlled by a plurality of process parameters," citing the disclosure "chamber pressure and wafer bias are used to control contact/via sidewall coverage" at col. 9, ll. 33-34 (brief, page 7).

Appellant also points to the disclosure "[b]y maintaining a high wafer bias, the trajectories of the ionized target atoms can be modified to be substantially perpendicular to the wafer, and thus in line with the depth direction of the contact/via structure, which enables many of the ionized atoms to reach the bottom of the contact/via structure" at col. 9, ll. 23-28 (brief, page 7; *see also* pages 8-9). In this respect, appellant argues that Kim does not teach or suggest "applying a bias power at a level with which to control the speed at which the ionized target atoms are projected toward a surface . . . [but] only teaches that the trajectories of the ionized target atoms can be altered with an application of a bias power," and thus, "the bias power range cited in Kim does not necessarily infer a bias power sufficient to splash deposited metal at a bottom of a cavity to the sidewalls of the cavity without some teaching or suggestion of such an action" (*id.*). At the same time, appellant contends that "the application of bias power recited within claim 1 is not limited to the exemplary levels cited in the [s]pecification" (*id.*, pages 7-8),

Appellant also argues that Kim does not provide motivation "to apply a bias power which is sufficient to splash" as required by claim 1, contending that the disclosure to apply bias power to obtain a layer "mostly deposited at the bottom of the contact via, rather than on the sidewalls" at col. 9, ll. 18-20, is for the purpose of preventing "deposition difficulties of aluminum upon the wetting layer," quoting the disclosure at col. 9, ll. 38-46 (brief, page 8).

Appellant relies on the arguments with respect to whether claim 1 is anticipated in contending that the grounds of rejection under § 103(a) are also in error (brief, page 11).

The examiner responds that the range of 100 to 200 W of wafer bias power disclosure at specification page 21, lines 25-29, does not "exclude values above and/or below this range from providing the same effect" of splashing "at least a portion of the titanium" layer deposited "at the bottom of the cavity onto the sidewalls," and "more particularly those bias levels above 200W are held to be sufficient to form a wetting layer while" causing splashing (answer, e.g., page 9). The examiner finds that Kim in Table 1 discloses IMP conditions for depositing titanium as a wetting layer "nearly identical to the ranges set forth in the instant application" at page 21, ll. 20-29 for applying the same material, "and additionally teaches . . . applying a wafer bias from 0-500 W . . . [which] includes the range of 100-200 W," thus providing "a clear rational for expecting that at least a portion of the titanium wetting layer will splash deposited metal at the bottom of the cavity onto the sidewalls" (*id.*, e.g., pages 9-10). On this basis, the examiner takes the position that there is sufficient evidence to support a conclusion of inherency because "the missing descriptive matter (splashing phenomenon) is necessarily present in the range of 0-500 W, more particularly for values inclusive and above that described in the instant application and even further at the upper limit of 500 W of Kim" (*id.*, e.g., page 10). With respect to the disclosure in Kim that "the titanium layer is 'mostly deposited at the bottom of the contact via, rather than on the sidewalls,'" the examiner finds that Kim does teach "that at least a portion of the deposited titanium is formed on the sidewalls," citing col. 9, ll. 18-20, and "wetting layer 26 formed on both the bottom and sidewalls of the contact via" as shown in **FIG. 7** (answer, e.g., page 10; *see also* pages 15-16).

Appellant replies to the examiner's finding of inherency with respect to "splash," contending that the "inherency contention is not adequately supported since there is no extrinsic evidence teaching that a wafer bias may be set at a level sufficient to splash deposited metal from the bottom of a cavity onto the sidewalls of the cavity," citing *Robertson*, 169 F.3d at 745, 49 USPQ2d at 1950-51, *Continental Can Co. USA v. Monsanto Co.*, 948 F.2d 1264, 1268, 20

USPQ2d 1746, 1749 (Fed. Cir. 1991), and *In re Oelrich*, 666 F.2d 578, 581, 212 USPQ 323, 326 (CCPA 1981) (reply brief, pages 2-5).

In my view, on this record, the issues raised with respect to the rejection of the claimed method encompassed by claim 1, as I have interpreted this claim above, as anticipated under § 102(e) are whether, *prima facie*, Kim discloses a method embodiment which can reasonably be inferred to necessarily and inherently include the function of resputtering or "splashing" at least one atom of titanium deposited in a layer at the bottom of a cavity to the sidewalls of the cavity during an IMP sputter deposition process employing wafer bias, even though Kim is silent in this respect, and thus is a method that is identical to the claimed method; and if so, whether appellant has provided effective argument or evidence that patentably distinguishes the claimed method encompassed by appealed claim 1 over such disclosure of Kim. *See, e.g., Spada*, 911 F.2d at 708-09, 15 USPQ2d at 1657-58 ("it was reasonable for the PTO to infer that the polymerization by both Smith and Spada of identical monomers, employing the same or similar polymerization techniques, would produce polymers having the identical composition," shifting the burden to appellant to show that the products are not identical); *In re Best*, 562 F.2d 1252, 1254-55, 195 USPQ 430, 432-33 (CCPA 1977) (the examiner reasonably concluded on evidence in the reference that process disclosed therein necessarily cooled the product which included the finding that the gas stream inherently removed generated ammonia even though the reference was silent on the matter, shifting the burden to appellants to provide effective argument or evidence that the "gas stream does not inherently remove generated ammonia"): *In re Skoner*, 517 F.2d 947, 950-51, 186 USPQ 80, 82-83 (CCPA 1975) (the description of the claimed invention in terms of certain physical characteristics not used in the reference, does not patentably distinguish the claimed invention over the reference where the examiner found that identical means were used in an attempt to achieve identical results such that the reference can be considered to inherently discloses the claimed invention, even though the examiner could not compare the process described by appellants and disclosed in the reference).

I find that as a matter of fact, the teachings of Kim would have directed one skilled in the art to deposit titanium as a wetting layer in a small feature contact/via by using the IMP sputter deposition process employing high wafer bias to deposit a layer of titanium as described at col. 9, ll. 16-36, immediately prior to the deposition of a bulk metal layer as I have discussed above. Indeed, both the examiner and appellant refer in arguments to this section of the reference with respect to the disclosure of IMP sputter deposition of titanium in Kim. *See In re Kronig*, 539 F.2d 1300, 1302-03, 190 USPQ 425, 426-427 (CCPA 1976) ("[T]he ultimate criterion of whether a rejection is considered 'new' in a decision by the board is whether appellants have had fair opportunity to react to the thrust of the rejection.").

I further find that Kim would have directed one skilled in this art to employ this IMP sputter deposition process for titanium with a high wafer bias when depositing titanium in small feature contact/via structures for the purpose of perpendicularly trajecting ions to the bottom of the contact/via and reducing the amount of titanium deposited on the sidewalls thereof. This direction to one skilled in this art extends to the first or "IMP Ti" process conditions in Table 1 at cols. 11-12, which is the only disclosed process that is specific to IMP sputter deposition of titanium and, indeed, the "preferred process conditions" for "IMP Ti" falls within or closely overlap with the "preferred process conditions" for "Ti" in Table 1 at cols. 13-14, the latter also including traditional sputter deposition conditions for the deposition of a titanium metal layer as I also discussed above.

Thus, I find in Kim the clear direction to one skilled in this art to the "optimum process conditions" for "IMP Ti" which includes high wafer bias at a "AC Wafer Bias (W)" of "450" and "AC Wafer Bias (-V)" of "40-70" without judiciously picking and choosing among the process conditions set forth in Kim, in order to form a wetting layer of titanium prior to the sputter deposition of aluminum in bulk in a small feature size contact/via. *See generally, In re Arkley*, 455 F.2d 586, 587-88, 172 USPQ 524, 526 (CCPA 1972) ("[F]or the instant rejection under 35 U.S.C. §102(e) to have been proper, the . . . reference must clearly and unequivocally

disclose the claimed compound or direct those skilled in the art to the compound without *any* need for picking, choosing, and combining various disclosures not directly related to each other by the teachings of the cited reference. Such picking and choosing may be entirely proper in the making of a 103, obviousness rejection, where the applicant must be afforded an opportunity to rebut with objective evidence any inference of obviousness which may arise from the *similarity* of the subject matter which he claims to the prior art, but it has no place in the making of a 102, anticipation rejection.").

Indeed, the "optimum process conditions" for "IMP Ti" sputter deposition of titanium to be followed by sputter deposition of a bulk metal layer of Al, reasonably appears to result in a description in Kim of the claimed process encompassed by claim 1 as a matter of fact under § 102(e), even in the absence of a disclosure that this embodiment of Kim employs "sufficient bias power" to resputter or "splash deposited metal at the bottom of the cavity to sidewalls of the cavity," in view of the process conditions necessary for this function stated in the written description of the specification, including the drawings.

In the written description of the specification, appellant discloses processes for producing wetting layers in "small, high aspect ratio cavities" wherein

> the power parameters . . . are preferably selected to (1) maintain enough sputtered metal neutrals for good sidewall coverage, (2) generate sufficient metal ions with sufficient impact energy to prevent metal build-up (and subsequent shadowing of the lower sidewalls) on the tapered portions of the cavity sidewalls, and (3) resputter the bottom of a cavity to improve lower sidewall coverage" [Specification, page 7, ll. 10-25.]

The "[w]etting layer 212 is preferably deposited on the sidewalls 208 of cavity 204 and the upper surface of dielectric layer 202 outside of cavity 204 . . . [as well as] on the upper surface of microelectronic topography lower portion 201 that is exposed by the cavity (cavity base 206)," as seen in specification FIG. 6, and "preferably is primarily composed of titanium," "[m]ore

preferably . . . relatively pure titanium" (specification, page 15, l. 28, to page 16, l. 4, and page 16, ll. 18-22).

The wetting layer deposition chamber 300 shown in specification FIG. 2 can be an "Endura PVD 5500, available from Applied Materials" (specification as amended at page 16, l. 26, to page 17, l. 3, in the amendment filed July 16, 2001), in which

> [a] pedestal bias supply 322 may be operably coupled to pedestal 306 for applying a bias power to pedestal 306. Pedestal bias power supply 322 is preferably configured to supply a bias power to pedestal 306 for drawing ionized metal atoms sputtered from target 302 toward pedestal 306, and thus the surface of microelectronic topography 200, at an approximately perpendicular angle. [Specification, page 18, ll. 5-9; *see also* page 19, ll. 16-18.]

Appellant notes again the "problem" of "build-up of deposited metal on tapered portions 210 of the cavity sidewalls," wherein "metal overhangs (or shadows) lower portions of sidewalls 208" (specification as amended at page 20, l. 14-20, in the amendment filed July 16, 2001).

Appellant discloses that such problems are solved by "pedestal bias" in the passage I quoted above in interpreting the term "splash," and again here for emphasis:

> The present method [which] is preferably configured to *deposit metal atoms with sufficient force to sputter previously deposited metal away from the ion impact area.* The impact energy of the metal ions on the microelectronic topography is largely determined by the pedestal bias. A greater pedestal bias will increase the energy with which the ionized metals impact the deposition surface. The present process preferably incorporates a pedestal bias configured to deposit metal atoms with sufficient force to sputter previously deposited metal and reduce or prevent the problems discussed above. *This feature allows for sputtering away of excess material on the tapered sidewall portions, and thus helps to prevent shadowing of other cavity sidewall portions. In addition, the sputtered metal ions may impact with previously deposited metal at the bottom of the trench with sufficient energy to resputter, or "splash," that metal onto lower cavity sidewalls 208.* [Paragraph abridging pages 20-21 of the specification as amended in the amendment filed December 9, 2002; emphasis supplied.]

The disclosure includes "a preferred embodiment" in which "[t]he bias power applied to pedestal 306 may be between 100 and 200 W. More preferably, the bias power applied to the

pedestal is about 135-165 W, and is optimally about 150 W" (specification, page 21, lines 25-29), which passage is relied on by the examiner (answer, page 3).

Appealed claim 1, as I have interpreted it above, encompasses but is not limited to the disclosed process which has the three objectives stated in the specification as quoted above. I find that one skilled in the art would have found in the written description in the specification that the IMP deposition process for forming a wetting layer of titanium in a cavity so disclosed employs sufficient bias power to perpendicularly traject sputtered titanium ions into a cavity, which metal titanium ions function to sputter away, that is, resputter, excess titanium deposited on tapered sidewalls of the cavity and, at the same time, may function to resputter or "splash" titanium atoms in the bottom of the cavity to the sidewalls. This person would have found no teaching or inference in the written description in the specification which separates on the basis of process conditions the function of resputtering or "splashing" of the titanium metal atoms from the bottom of the cavity to the sidewalls from the functions of the perpendicular trajecting of titanium ions into the cavity and resputtering of the titanium atoms on the sidewalls of the cavity. In other words, based on the disclosure, process conditions necessarily resulting in the functions of the perpendicular trajecting of titanium ions into the cavity and resputtering of the titanium atoms on the sidewalls of the cavity would necessarily result in the resputtering or "splashing" of at least one titanium metal atom from the bottom layer of the cavity to the sidewalls.

Accordingly, on this record, the IMP sputter deposition process employing high wafer bias used to deposit titanium in small feature contact/vias as described in Kim employs sufficient bias power to perpendicularly traject titanium ions into small contacts/vias and remove excess titanium from the sidewalls of the contacts as embodied in the "optimum process conditions" for "IMP Ti" in Table 1 thereof, and thus, provides substantial evidence that, *prima facie*, this embodiment reasonably appears to be identical to the claimed method encompassed by appealed claim 1 within the meaning of § 102(e) even though Kim is silent with respect to the resputtering

or "splashing" of at least one titanium metal atom from the bottom layer of the cavity to the sidewalls.

Therefore, the burden shifts to appellant to submit effective argument or objective evidence to patentably distinguish the claimed method encompassed by claim 1 from this embodiment of Kim. *Spada*, 911 F.2d at 708-09, 15 USPQ2d at 1657-58; *Best*, 562 F.2d at 1254-55, 195 USPQ at 432-33; *Skoner*, 517 F.2d at 950-51, 186 USPQ at 82-83.

I have again evaluated all of the evidence of anticipation and non-anticipation in the record as a whole, giving due consideration to the weight of appellant's arguments in the brief and reply brief. *See generally, Spada*, 911 F.2d at 707 n.3, 15 USPQ2d at 1657 n.3.

The description of an embodiment in a reference is required to anticipate a claimed invention even where a range of the invention as claimed and a range as disclosed in the reference *overlap*. *Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 780-81, 227 USPQ 773, 777-78 (Fed. Cir. 1985). On the present record, the "optimum process conditions" for "IMP Ti" in Kim Table 1 reasonably appears to provide that embodiment. Indeed, while there is a range stated for "AC Wafer Bias (-V)" of "40-70" in Kim Table 1, this range is above the lower limit of "high wafer bias (i.e., at least about –30 V)" specified in Kim (col. 9, l. 21), and thus, this range falls *entirely* within claim 1. *See In re Perkins*, 346 F.2d 981, 984, 146 USPQ 63, 65 (CCPA 1965) (claimed range encompasses prior art range).

On this record, appellant's argument that Kim is silent with respect to using sufficient bias power to "splash," that is, resputter a titanium metal atom from the bottom of the cavity to a sidewall thereof, is insufficient to patentably distinguish the claimed method over that disclosed in Kim. *Spada*, 911 F.2d at 708-09, 15 USPQ2d at 1657-58; *Best*, 562 F.2d at 1254-55, 195 USPQ at 432-33; *Skoner*, 517 F.2d at 950-51, 186 USPQ at 82-83.

Furthermore, appellant does not distinguish Kim by correctly pointing out that Kim discloses depositing a titanium layer mostly on the bottom rather than on the sidewalls of the cavity by the titanium IMP sputtering process disclosed at col. 9 thereof, because there is no

limitation in claim 1 corresponding to this argument, and indeed, there is no such disclosure in the written description in the specification. There is also no limitation in claim 1 or disclosure in the written description in the specification which establishes that a variety of parameters determines whether titanium at the bottom of the cavity will resputter or "splash" *per se* as appellant alleges. As I found above, on this record, the bias power necessary to resputter or "splash" at least one atom of titanium from the bottom of the cavity to a sidewall, which is all that claim 1 requires, is that which will cause perpendicular trajecting of titanium ions into the cavity and removal of titanium metal from the sidewalls by resputtering. The process conditions necessary to accomplish such results are encompassed by the claimed method encompassed by claim 1 and by the "optimum process conditions" in the "IMP Ti" process in Kim Table 1 as shown by the discussion of that process in col. 9 of Kim as discussed above. Indeed, the other conditions affecting the IMP deposition disclosed in Kim pointed to by appellant are not disclosed to affect the reduction of titanium deposited on the sidewalls by the use of high wafer bias (*see, e.g.*, col. 9, ll. 32-37). Appellant's arguments with respect to the perpendicular trajectory of metal ions when high wafer bias is employed, fall for several reasons. Not only is this characteristic inherent to the claimed method, as indeed it is recognized as an inherent characteristic of IMP sputter deposition processes in the written description of the specification, but there is no limitation in such respect in claim 1 and one skilled in the art would infer from Kim that this characteristic is indeed necessarily inherent when high wafer bias is employed.

Thus, at best the claimed method amounts to appellants' elucidation of the mechanism of an old process or discovery of a new benefit of that process which, of course, does not render the old process again patentable simply because those practicing the process of Kim may not have appreciated the mechanism or a particular result produced thereby. *See, e.g., Spada*, 911 F.2d at 707, 15 USPQ2d at 1657; *In re Woodruff*, 919 F.2d 1575, 1577, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990); *W.L. Gore & Assocs. v. Garlock, Inc.*, 721 F.2d 1540, 1548, 220 USPQ 303, 309 (Fed. Cir. 1983) ("[I]t is . . . irrelevant that those using the invention may not have appreciated

the results[,] . . . [otherwise] it would be possible to obtain a patent for an old and unchanged process. [Citations omitted.]"); *Skoner*, 517 F.2d at 950, 186 USPQ at 83.

Accordingly, based on my consideration of the totality of the record on appeal, I have weighed the evidence of anticipation found in Kim with appellant's countervailing evidence of and argument for no anticipation in fact and find that the claimed invention encompassed by appealed claims 1, 3 through 7 and 11 are anticipated as a matter of fact under 35 U.S.C. § 102(e).

Therefore, I am of the opinion that this ground of rejection should be affirmed. It follows that I am also of the same opinion with respect to the grounds of rejection of claims 2 and 8 through 10 because appellant provides no further argument with respect thereto (brief, page 11).

CHARLES F. WARREN Administrative Patent Judge	) BOARD OF PATENT) APPEALS AND) INTERFERENCES

Appeal No. 2005-0325
Application No. 09/476,669

Daffer McDaneil LLP
P.O. Box 684908
Austin, TX 78768